

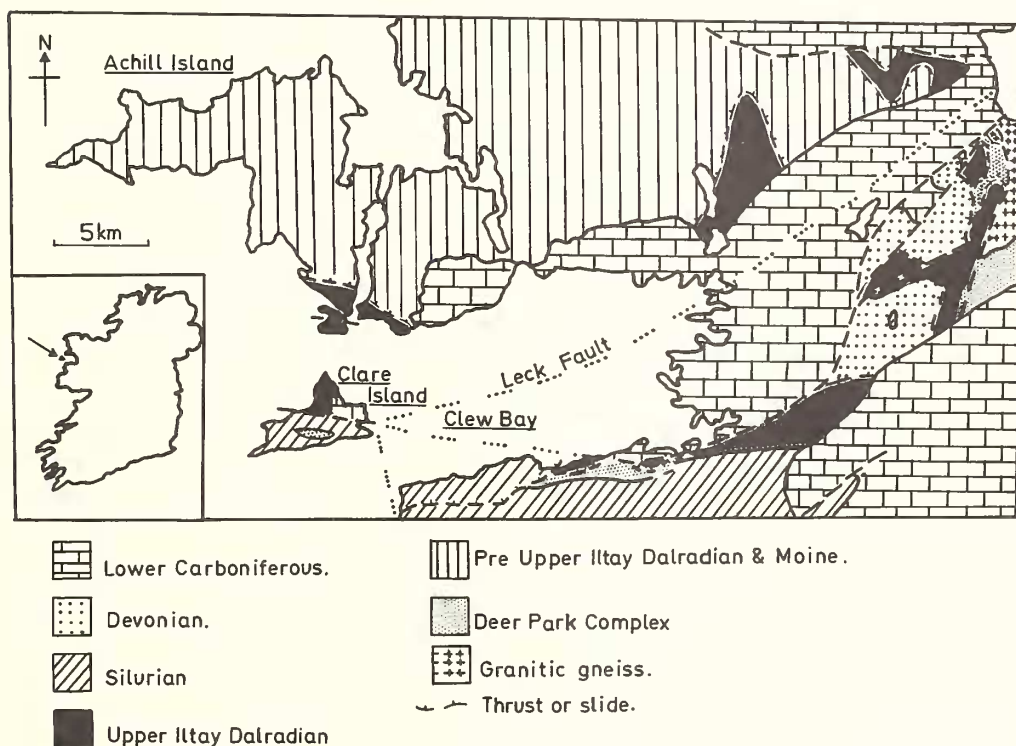
A *PROTOSPONGIA* FROM THE DALRADIAN OF CLARE ISLAND, CO. MAYO, IRELAND

by A. W. A. RUSHTON and W. E. A. PHILLIPS

ABSTRACT. The largest specimen of *Protospongia hicksi* Hinde yet found is described from the top of the Upper Ilty Dalradian succession in western Ireland. The age is uncertain but suggestive of Middle Cambrian (St. David's Series).

THE northern part of Clare Island, Co. Mayo, is underlain by a succession of graphitic pelites and cherts, coarse turbidites, and local spilitic lavas and tuffs, which are considered to be the youngest part of the Ilty Dalradian succession of north Mayo (Phillips 1966; Kennedy 1969; Phillips *et al.* 1969; Kennedy *et al.* 1972). The location and stratigraphical succession are outlined in text-fig. 1 and Table 1 respectively.

During the summer of 1971 one of us (W. E. A. P.) collected a specimen of *Protospongia hicksi* Hinde on the northern promontory of Clare Island, from near the



TEXT-FIG. 1. Geological sketch-map of northern Mayo.

TABLE 1. The stratigraphy of the Iltay Dalradian in north Mayo

Group	Formation	Member	Minimum approx. thickness in metres	Lithology
Lough Feeagh Group Upper part (cf. Upper Iltay Dalradian) thickness c. 2 km	Ballytoohy Formation	Ooghcorragaun Pelitic and Psammitic Member	70	Alternating dark cherty pelite and psammite
		Benilra Psammitic Member	390	Graded psammite
		Tonaltatarrive Spilitic Member	36	Black pelite, grey chert, spilitic, tuff and limestone
		Siorr Chert Member	24	Black-grey chert,* thin psammities
		Carrickarollagh Iron Member	30	Black pelite, grey chert, siderite
Lower part	(Unexposed interval) (Divisions not listed)			
West Achill Group (cf. Middle Iltay Dalradian) thickness c. 5 km	(Divisions not listed)			
Inver Group (cf. Lower Iltay Dalradian) thickness c. 1 km	(Divisions not listed)			

The horizon with *Protospongia* is indicated by the asterisk.

top of the Siorr Chert Member of the Ballytoohy Formation. The specimen was found on an interface between a band of graphitic chert and one of graphitic and pyritic pelite. The outcrop (Irish grid reference 069370 286940) is one of several on a bare hillside, and has been marked in the field by a red cross.

This specimen is the first fossil of stratigraphical significance to be found in the Dalradian of Ireland, and establishes the presence of Cambrian rocks in the northern half of Ireland. The stratigraphical and structural setting and the significance of the specimen will be discussed elsewhere (Phillips, in press).

Genus PROTOSPONGIA Salter 1864

Protospongia hicksi Hinde

Plate 23

1887 *Protospongia Hicksi* Hinde, pl. 1, figs. 2, 2a [figured].

1888 *Protospongia Hicksi* Hinde, p. 107 [described].

1920 *Protospongia hicksi* Hinde; Walcott, p. 307, pl. 80, figs. 3, 3a, b [synonymy].

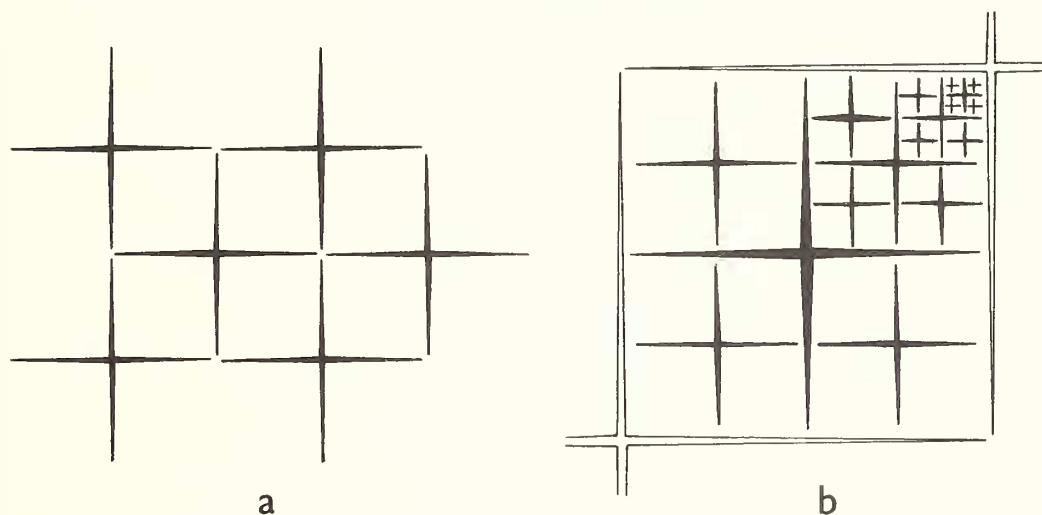
1966 *Protospongia hicksi* Hinde; Rigby, p. 550, pl. 66, figs. 1, 2 [description of American specimen].

The holotype (Sedgwick Museum A1035) is from the Menevian Beds (mid-St. David's Series), Porth-y-rhaw, near St. David's, Pembrokeshire.

Description of the Irish specimen. The specimen (Trinity College, Dublin, no. TCD 9834) seems to be much the largest *Protospongia* recorded. It lies on a bedding-plane cut by many joints, along some of which there has been a little tectonic movement and along others quartz crystals have grown. It was collected in several pieces. Spicules cover an area roughly 300 mm by 150 mm and originally extended well beyond the limits of the fragments collected. In places the spicules have weathered away, leaving a feeble impression on the underlying rock; in other places they are preserved in silica. These were thrown into relief by abrading the matrix with powdered dolomite in an air-blast.

The spicules are cross-shaped tetracts ('stauracts') of various sizes referable to six 'orders'. Although the spicules are partly disarranged their original disposition is seen in places (Pl. 23, fig. 1). The largest or 'first-order' spicules are arranged in a quincunx (text-fig. 2a). Each second-order spicule is centred in the squares made by the first-order spicules, and the second-order spicules make squares for the third-order spicules; this pattern is repeated on a successively smaller scale for the fourth-, fifth-, and sixth-order spicules (text-fig. 2b). The resulting lattice is not quite regular, nor square, nor truly rectangular; the general orientation of the lattice veers through about 25° across the slab, suggesting that the sponge's body, now flattened, was once conical.

The larger spicules in general overlie the smaller. The smaller spicules (third to sixth order) are domed, with the tips of all four rays sloping down into the matrix; in life the concave side probably faced internally, as in *Pleodioria* Öpik (1961, p. 50). There is no evidence of a polar ray, like those shown in '*Protospongia?* sp.' by Henningsmoen (1958, pl. 7, figs. 4-6), and in *Pleodioria tomacis* Öpik (1961, text-fig. 16B).



TEXT-FIG. 2. Idealized drawings of *Protospongia*, showing (a) first-order spicules arranged quincuncially, $\times \frac{1}{2}$ approx. (b) arrangement of first- to sixth-order spicules: parts of two first-order spicules are shown in outline, one second-order, and four each of the third- to sixth-order spicules are shown solid black; $\times 2$ approx.; for clarity all the rays are drawn too thick and too short; they should overlap.

There is no stump seen at the centre of the stauracts, nor was a polar ray exposed when the centre was undercut or air-blasted away.

At some places (e.g. about 2 cm below and to the left of the centre of Pl. 23, fig. 1) there are small rod-like spicules which do not appear to be parts of stauracts but which may represent dermal spicules (diacts). There is no evidence that the sponge, large as it was, had more than a single layer of spicules in its wall.

The features so far described agree with Rigby's description of a well-preserved mould of *P. hicksi*; the present specimen differs from Rigby's in having six rather than five orders of more robust and much larger spicules. Three first-order spicules have a 'radius' (centre to tip) of 20, 23, 24 mm, and other, less distinct ones appear to have exceeded 30 mm; near the centre the rays are about 0.65 mm thick. Four second-order spicules have radii of 9.8, 10.0, 12.0, 12.8 mm, and a thickness of about 0.45 mm. Third-order radius averages 5.6 mm (22 measurements), thickness about 0.35 mm. Fourth-order radius 2.5 mm (very variable), thickness about 0.28 mm. Fifth-order radius 1.3 mm, thickness a little more than 0.2 mm. Sixth-order radius 0.6 mm, thickness less than 0.2 mm. The second-order spicules compare in size with the first order of Hinde's and Rigby's descriptions. The smaller spicules are stouter than Rigby's but the sixth-order spicules compare well with Hinde's fifth-order spicules.

Comparisons. The present specimen can be compared only with large species of *Protospongia* with several reducing orders of spicules, namely *P. fenestrata* Salter, *P. hicksi*, and also, perhaps, *P. erixo* Walcott (1920, p. 353, pl. 79, figs. 2, 2a-c). Although the largest of the spicules are much bigger than those previously described, they have throughout their size-range the same general proportion of thickness to radius as the spicules of *P. hicksi* but not the slender ones of *P. fenestrata* (Hinde 1887, pl. 1, figs. 1, 2). The species described from Metis, Quebec, by Dawson (1889), have only three orders of spicules, those of the first order being arranged orthogonally rather than quincuncially, and are much smaller over-all.

IMPLICATION OF AGE

We have misgivings about assessing the age of the Ballytoohy Formation on the basis of a single fossil from a group of which the record is most imperfect; nevertheless, this fossil demands some discussion.

Species of the genus *Protospongia* are described from the Middle Cambrian to

EXPLANATION OF PLATE 23

Figs. 1, 2. *Protospongia hicksi* Hinde from the Siorr Chert Member of the Ballytoohy Formation, northern promontory of Clare Island, Co. Mayo, Ireland (grid ref. 069370 286940). No. TCD 9834. 1, Part of specimen (less than half is shown), $\times 1$. Compare the orientation of the lattice to left and right of figure. 2, Part of specimen at bottom centre of Fig. 1, $\times 2$. The orientation in relation to Fig. 1 is reversed; the incident light is at a low angle to show the doming of the spicules. The white pointer shows a square of four sixth-order spicules.

Fig. 3. *P. hicksi*, holotype, from the Menevian Beds, Porth-y-rhaw, Pembrokeshire (Hinde 1887, pl. 1, figs. 2, 2a). $\times 2$. Sedgwick Museum A1035.



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3



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low Ordovician (Dawson 1889). Stauract spicules referred to the genus (perhaps unjustifiably by present standards) are recorded from the Lower Cambrian by Walcott (1890, p. 597, pl. 49, fig. 2) and from the Upper Cambrian (Merioneth Series) by Westergård (1944, p. 32). *P. hicksi*, however, is known only from the Middle Cambrian (St. David's Series), and the same seems generally true for large species of *Protospongia* composed of numerous spicules of several orders of size. The present specimen, then, suggests a Middle Cambrian age for the Siorr Chert Member of the Ballytoohy Formation. It is stressed, however, that this assessment may be called in question by the discovery of new specimens of *Protospongia*; the genus existed both before and after the times of the known specimens of *P. hicksi*, represented by undescribed species. Indeed Westergård has figured (1909, pl. 2, fig. 26) a doubtful *P. fenestrata* from beds as high as the Tremadoc: it consists only of a few small spicules of two or three orders of size, the largest of 6 mm radius; the 'fenestrate' arrangement is not preserved, but that specimen clearly shows that caution is needed in interpreting the age of the present one.

The horizon in the Dalradian sequence which is most definitely fixed palaeontologically is the Leny Limestone of Leny Quarry, near Callander, Perthshire. The Leny Limestone lies within the Leny Grits and is an integral part of the Upper Itay Dalradian succession of Scotland. The age of the Leny Limestone was assessed by Cowie *et al.* (1972, p. 17) as late Lower Cambrian (Comley Series), and may therefore be older than the Siorr Chert Member of the Ballytoohy Formation. Lithologically the Ballytoohy Formation is closely comparable with the Highland Border 'Series' of Scotland which is considered to lie at a higher stratigraphical level than the Upper Itay Dalradian. The age of the rocks referred to the Highland Border Series is generally uncertain, but Downie *et al.* (1971, pp. 5, 19, 24) have obtained an assemblage of acritarchs from a sample of black mudstone within the Greenstone Division of the Highland Border Series at Edzell, Angus, to which they tentatively assign an age between the Tremadoc and Llanvirn. This is so considerably later than the age postulated for the Ballytoohy Formation as to suggest that the lithologies typical of the Highland Border Series were developed at different times, at least in eastern Scotland and western Ireland.

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REFERENCES

- COWIE, J. W., RUSHTON, A. W. A. and STUBBLEFIELD, C. J. 1972. A correlation of Cambrian rocks in the British Isles. *Spec. Rep. geol. Soc. Lond.* 2, 42 pp., 6 pls.
- DAWSON, J. W. 1889. New species of fossil sponges from the Siluro-Cambrian of Little Metis on the Lower St. Lawrence. *Trans. R. Soc. Can.* 7, sec. 4, 31-55, pl. 3.
- DOWNIE, C., LISTER, T. R., HARRIS, A. L. and FETTES, D. J. 1971. A palynological investigation of the Dalradian rocks of Scotland. *Rep. Inst. geol. Sci.* 71/9, 30 pp., 3 pls.
- HENNINGSMOEN, G. 1958. The Upper Cambrian faunas of Norway with descriptions of non-Olenid invertebrate fossils. *Norsk geol. Tidsskr.* 38, 179-196, pls. 1-7.

- HINDE, J. G. 1887–1912. A monograph of the British fossil sponges. Vol. 1. Sponges of the Palaeozoic and Jurassic strata. *Palaeont. Soc. [Monogr.]* (1), 1–92, pls. 1–8 (1887); (2), 93–188, pl. 9 (1888).
- KENNEDY, M. J. 1969. The structure and stratigraphy of the Dalradian rocks of north Achill Island, County Mayo, Ireland. *Q. Jl. geol. Soc. Lond.* **125**, 47–81.
- PHILLIPS, W. E. A. and NEALE, E. R. W. 1972. Similarities in the early structural development of the northwestern margin of the Newfoundland Appalachians and the Irish Caledonides. *Proc. XXIV Int. geol. Congr.*, Montreal. Sec. 3, 516–531.
- ÖPIK, A. A. 1961. The geology and palaeontology of the headwaters of the Burke River, Queensland. *Bull. Bur. miner. Resour. Geol. Geophys. Aust.* **53**, 1–249, pls. 1–24.
- PHILLIPS, W. E. A. 1966. *The geology of Clare Island, Co. Mayo, Ireland*. Unpubl. Ph.D. thesis, University of Dublin.
- KENNEDY, M. J. and DUNLOP, G. M. 1969. Geologic Comparison of Western Ireland and Northeastern Newfoundland. *Mem. Amer. Ass. petrol. Geol.* **12**, 194–211.
- RIGBY, J. K. 1966. *Protospongia hicksi* Hinde from the Middle Cambrian of western Utah. *J. Paleont.* **40**, 549–554, pl. 66.
- WALCOTT, C. D. 1890. The fauna of the Lower Cambrian or *Olenellus* zone. *Rep. U.S. geol. Surv.* **10**, 509–774, pls. 43–98.
- 1920. Middle Cambrian Spongiae. *Smithson. misc. Collns.* **67**, (6), 261–364, pls. 60–90.
- WESTERGÅRD, A. H. 1909. Studier öfver Dictyograptusskiffern och dess gränslager, med särskild hänsyn till i Skåne förekommande bildningar. *Acta Univ. lund.*, N.F. Afd. 2, **5**, (3), 1–79, pls. 1–5.
- 1944. Borrningar genom Skånes alunskiffer 1941–42. *Sver. geol. Unders. Avh.*, Ser. C, **459**, 1–45, pls. 1–6.

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